MANAV RACHNA INTERNATIONAL UNIVERSITY

Short Synopsis

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DESIGN AND DEVELOPMENT OF ENERGY EFFICIENT ROUTING PROTOCOL BASED ON LINK STABILITY IN MANETS

DEPARTMENT OF CSE

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ABSTRACT

MANETS (Mobile Adhoc Networks) are collection of various nodes which can communicate with each other in the transmission range without any central controller. Since nodes are mobile so it affects the topology of a network. Each node in the network behaves router as well as host. The efficiency and performance of a network depends on how well information is routed from source node to destination node. Energy is an important parameter to be conserved to enhance network lifetime. Various protocols have been proposed to conserve the energy in MANETS. Mobility of nodes results in network changes so it reduces overall stability of link. Since link stability reduces so it degrades the performance of any routing protocol. Links may be unstable due to wireless properties of channel. Adhoc Network has constraints such as bandwidth allocation, packet overhead, attacks of malicious nodes, wireless links which may result in complicated routing process. Earlier proposed work considered either energy or stability of link or bi-objective function considering link stability and energy drain rate of node. The proposed approach will consider multi-objective function which will consider both energy saving as well as stability of link using variable sized sampling window for dynamic link state with further optimization using Metaheuristic Techniques. The proposed work will compare various network parameters i.e., throughput, end to end delay, residual energy of node, energy drain rate of node, with existing routing protocols .Hence in this thesis both energy and link stability is considered for designing routing protocol which will be further optimized using Metaheuristic Approach such as either evolutionary technique Genetic Algorithm or Particle Swarm Optimization.

Key words: Link Stability, Energy, Mobility ,MANETS

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1. Introduction

Due to fast progress of Wireless Communication Adhoc networks has become very popular during last two decades. A Mobile Adhoc network (MANET) is set of mobile nodes without any infrastructure. It does not have any central controller. Each node in a MANET is free to move in any direction. Each node is having a router that may have multiple hosts .It is having dynamic topologies, constrained bandwidth, variable capacity links, Energy constrained operation and limited physical security. MANETS has applications in Search and Rescue operations, Military Applications etc.

Routing

Each node in an adhoc network which has to forward data participates in the formation of the network. This is similar as in case of internet. Routing Protocols are self starting and adapt themselves to any change in the network. Mobile nodes that move from one place to another results in link breakage. Position based routing protocols considers geographical information of node which can be collected using GPS (global positioning system).Topology based routing protocols are further subdivided as proactive, reactive or hybrid protocol.

Types of Routing Protocols

Proactive Routing protocols In these routing protocols each node maintains a routing table. If there is high mobility among nodes then it requires large overhead to maintain the table. **DSDV(Destination Sequenced Distance Vector)** uses distance vector algorithm. It avoids loop problem by periodically sending routing updates. Since each node uses a sequence number to tag itself. As topology of network changes frequently so a new sequence number is essential before network reconverge itself. So it is suited for small adhoc networks with low mobility.

Reactive Routing protocols

a) **DSR (Dynamic Source Routing)** This protocol initiates a request from source which is passed to neighboring nodes and then each node add itself to the address till destination is

reached.After reaching at the destination complete address is passed to source and a route is established. As source node sends data packet to destination in which complete route is there in packet header so it is called source initiated routing.

b) AODV(Ad hoc on demand distance vector routing protocol) In DSR each packet carry complete information of intermediate routes whereas AODV packets carry only the address of destination node. AODV route reply carry only destination IP address and its sequence number.AODV is suitable for dynamic environment but as the network grows extra delay is introduced in the network.

c) **Hybrid Routing Protocol:**It combines the benefits of both table driven and Reactive routing protocol**s. I**n **ZRP (Zone Routing Protocol)** inside radius of zone it maintains table entries just like proactive while outside the zone reactive protocol is adopted.

In **Associativity based Routing** proposed by C.K.Toh, he preferred stable link over transient links.If link exists for a threshold time period it is considered to be stable.This threshold time is given as T_{th} =(2* r)/s where r is the radio range and s is the relative speed of two nodes. This proposed scheme considers that after threshold time devices will be together for long duration but that is not practically possible.

In **Signal Stability Adaptive Routing** (SSA) tries to differentiate between strongly connected links with weak links. A link is stable if it remains active for some specific time duration.This approach eliminates the use of weak link as that link is having more signal fluctuation.

In **Routelifetime Associativity based routing**(RABR) approach it finds the time when receieved signal falls below threshold value. It only considers movement pattern of nodes but does not consider various losses involved with wireless such as fading,path loss etc.

As these were basic routing protocols in MANETS which donot optimize both for energy conservation in the network as well as satisfying quality of service parameters(QOS parameters)such as link stability,Residual energy of a node,Available bandwidth etc.

Clustering

Clustering helps to increase scalability of network for large number of nodes. Divide the network into disjoint or overlapping group of nodes. These groups of nodes are called clusters. There is a special node in each group known as Cluster Head(CH).Rest all nodes are member nodes .Gateway nodes help to exchange information between two clusters. Various algorithms have also been proposed for choosing CH(cluster head) in MANETS. In LCA (Linked Cluster Algorithm) a unique ID is provided to each node. The node which is having highest ID among the neighbors is chosen as CH. In WCA (Weighted Cluster Algorithm) each node is assigned some weight based on metrics such as battery power.

Characteristics of MANETS:

- **Dynamic Topology:** In MANETS every node is mobile**.** So it can leave the network at any time which makes routing a difficult process.
- Node in the transmission range acts as both router and host.
- Multi hop structure-If destination is not there within the radio range of any node then it can go for muti-hop routing.
- There is no central controlling authority in MANETS.
- Reliability, Security, Link bandwidth of wireless links is inferior to as compared of wired ones.
- Battery power is limited and if an overloaded node comes down then whole network collapses so energy of any node is very precious.
- It should be scalable i.e. for ready to use for large as well as small network.

Application areas of MANETS:

- **Military battlefield**: Adhoc networks first became popular in military operations using ARPANET. They can be deployed easily to gather information among soldiers and tracking vehicles.
- **Search and Rescue operations**: Adhoc networks can be useful during earthquake, flood, fire operations etc. Ship to ship communication also makes rescue operations easier.

- **Personal Data Networks**: These days every person uses many gadgets .These gadgets may talk with each other using MANETS.
- **Sensor Networks**: This is used in home automation systems. As various sensors can be deployed using Adhoc networks.

2. Literature Review

In this section different routing protocols considering parameters related to energy efficiency and link stability are studied.

F .De Rango et. al [5] gave a unique routing protocol which considered both link stability as well as energy aware parameters. He proposed LAER (Link-stability and Energy aware Routing protocols).He considered link stability along with minimum drain rate energy consumption.

Zhu and Wang [33] told that only considering minimum energy path can result in increased route setup time, more routing overhead and increased routing maintenance issues. They proposed PEER(Progressive Energy Efficient Routing) which results $2/3^{rd}$ path overhead saving and 50% transmission energy savings.

Wu et. al [29] gave a unique routing protocol considering both link stability as well as bandwidth efficiency. The author has used distributed Q-learning for maintaining network status in AODV. In QLAODV, each node exchange HELLO message with neighbor node. Every node calculates mobility factor (MF) and bandwidth factor(BF). Then node maintains Q value, MF and BF. Node forwards the data to next node with maximum Q-value.

Samar and Wicker[20][21] developed the models for mathematical computation of links dynamics in the optimization of design of any protocol. The authors presumed that nodes are moving with same speed and direction to calculate the lifetime of link. Later Wu has computed lifetime of links using two state Markov's model. The author has presented analytical framework as well as simulation results for characterization of link.

Q. Song[25] proposed a new idea to calculate the link stability which is based on link connectivity changes. They used variable size of sampling window in HELLO packet format to estimate the transition rate of a link using Markov's model. Routing scheme (OLSR,AODV,DSR) changes according to estimated link transition rate. So here link

duration is used to assess quality of link. **Idoudi et al**[13] has proposed a new model to compute link stability as well as path stability. He has computed MSD (Maximum Stability Duration) of a link i.e. the maximum duration for which link was connected. According to calculated values of MSD he has categorized links as low stability, average stability and high stability. Then he has defined path stability same as low stability path, average stability path and high stability path. He concluded that path stability closely follow link stability. He also found that proactive routing protocol has more number of low stability paths in comparison to medium or high stability paths.

Ali Moussaoui[18] presented a unique idea to select MPR(Multi point Relays) in proactive routing protocol such as OLSR. He has calculated SND (Stability function of Nodes) and FND (Fidelity function of Nodes) .Then he has chosen the path among two nodes with minimum value of SND which is largest among all candidate paths. As number of nodes increases value of calculations involved in selecting MPR in proposed OLSR routing mechanism is greatly reduced. This method improves QOS (Quality of Service) parameters such as packet loss and response time.

Malathi et al[16] proposed a routing protocol which is robust in route failure. As author has considered three important parameters i.e. quality of channel, quality of link as well as energy level of node. Since channel is the medium through which information travels. So channel capacity is calculated then link is measured using link life time and then residual energy of nodes is considered. So proposed scheme results in less number of route failures by taking into consideration all three parameters i.e. channel quality, link quality and residual energy of nodes.

Mammar S.[17] has enhanced traditional routing method AODV by predicting link failure to enhance QOS. He has predicted link failure by measuring signal strength which will optimize link management and reduces the link failure rate. He has suggested PF_AODV (Predict Failure AODV) by measuring link strength. If link is going to break then another link from link cache is chosen. Simulations prove better results as compared to AODV.

Sarma and Nandi [22] has suggested route stability method to enhance QOS. The author suggested RSQR (route stability based QOS routing) in MANETS. Reduction in probability of link failure results in better route. Longer links are more unstable as they come near to radio

range. So there is a compromise between shortest path with longer links(unstable) or longer routes with stable links.

Description of Broad Area

Link breakage is a common phenomenon in MANETS due to changing topologies. Wireless links are inferior as compared to wired networks. So link stability is a important parameter to be studied. Bandwidth is also limited in wireless networks. So increased link stability results in better utilization of bandwidth. It ultimately enhances QOS (Quality of Service) in networks. Stability of link can be estimated by following methods:

1. Signal Strength
2. Pilot signals –Used in ABR(Associativity Based Routing)
3. Relative speed between two nodes forming the link
4. Link duration distribution or Link lifetime
5. Remaining battery power of nodes

Energy is also an important resource to be conserved in order to increase lifetime of any network. MANETS has five layered architecture .Power Saving can be done at MAC layer using PAMAS(Power Aware Multiple Access with Signaling).In this protocol it avoids overhearing by a node thus saving about 40-70% of energy. Network layer helps in energy efficient routing at the network layer. Since single layered stack architecture will not meet today's requirements so cross layer design is proposed.

In MANETS ,there are three methods to detect link breakage**.**

a) Route Time Out : Routes where packets do not flow any longer. So that route is currently not in use can be termed as timeout. Reactive routing protocol such as AODV supports this method**.**

b) Neighbor discovery: Nodes which are in neighborhood constantly send Hello packets. So link which does not receive HELLO packet can be treated as link break. Proactive Routing such as OLSR supports it. It is not very suitable for on demand protocols.

c) Notification from link layer to network layer: It is a cross layer method in which if link layer receives link break information will inform upper Network Layer. Thus it will avoid congestion of network .

Routing Protocols considering link stability can be broadly categorized into two categories:

Distance based routing protocols : In it we try to minimize the distance between a node and its successor.

Mobility based routing protocols: In it we try to consider the parameters related with mobility of nodes such as stability of a link, movement of node and their speeds, probability of any node to remain in radio range etc.

3. Motivation

The motivation behind this work comes from to develop a routing protocol which considers link duration as well as supports energy requirements of the network. Much work has been done in the area of MANETS while suggesting a good routing protocol at the network layer. But there is a scope of improving it either by changing interval of beaconing at the network layer or by considering MAC layer as well as physical layer along with network layer while designing an efficient routing protocol.

When stability of link is prime criteria then routing protocol is chosen either on the basis of signal strength or on the basis of minimum distance between nodes. If signal strength or distance between nodes is taken for ensuring stability of link then it may end up choosing nearest node with higher value of hop count. So our motivation comes from that parameters chosen should not increase delay of network resulting in degradation of QOS (quality of service) requirements.

4. Challenges

- Higher mobility of nodes can result into more link breakage. Hence it will further reduce the average link duration. So we should select mobility model according to requirement of the network.

- Unbalanced distribution also leads to frequent network partitions. So other metrics will be considered such as traffic of any node, residual bandwidth along with energy requirements.

5. Problem Statement

To design energy efficient routing protocol while satisfying link stability criteria in MANETS. Since energy is crucial parameter while designing any routing protocol in MANETS. We will try to optimize parameters such as total energy consumed on any path while transmitting data as well as considering residual energy of a node which should not burden any single node along with stability of a link between two nodes in a wireless scenario.

Objectives

(i) To study various routing protocols of MANET and evaluate their efficiency through comparative analysis, further to focus on the limitations of existing approaches.

(ii) To develop an energy aware routing approach by eliminating the low energy nodes thus suppressing the table size, hence eliminating dispensable entries of the routes within the network from the routing table.

(iii) To simulate the proposed and developed approach through NS2 for further validation.

(iv) To compare the proposed approach with existing approaches and validate the results through enhancement of QOS parameters like reduced overhead, end-to-end delay, throughput, Residual Energy, Jitter etc.

(v) To utilize some meta-heuristic approach for further optimizing the results.

6. Methodology to be adopted

It is planned to propose a routing protocol with multi-objective function which will consider both the parameters energy as well as stability of the link. For increasing the scalability of the network clustering technique can be applied. So in the first phase we try to make a model which will conserve energy of the network along with enhancing link stability using variable sized sampling window for dynamic link state. Further optimizing the various network parameters such as residual energy of node, end to end delay, throughput metaheuristic techniques such as GA (genetic algorithm),PSO(particle swarm optimization) can be applied.

7. Proposed Outcome of the research

It is planned to implement proposed approach considering both energy as well as link stability with the help of analysis and simulation using NS2.The proposed protocol will ensure enhancing energy efficiency and increasing link stability of the network.

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